GMI Combined Strat/Trop Model Update

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Thanks to core modeling team:
Jules Kouatchou, Hamid Oloso,
also Peter Connell

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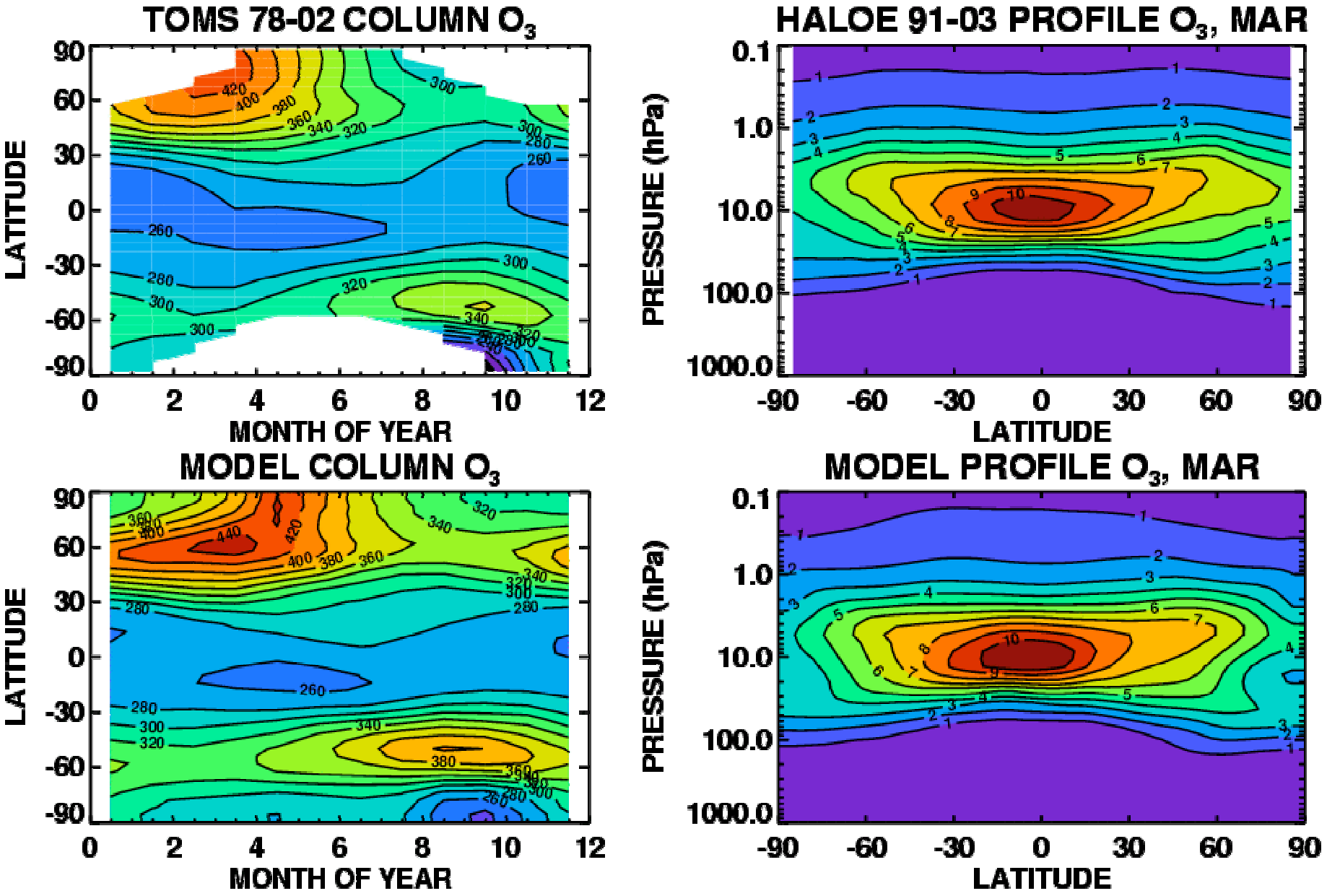
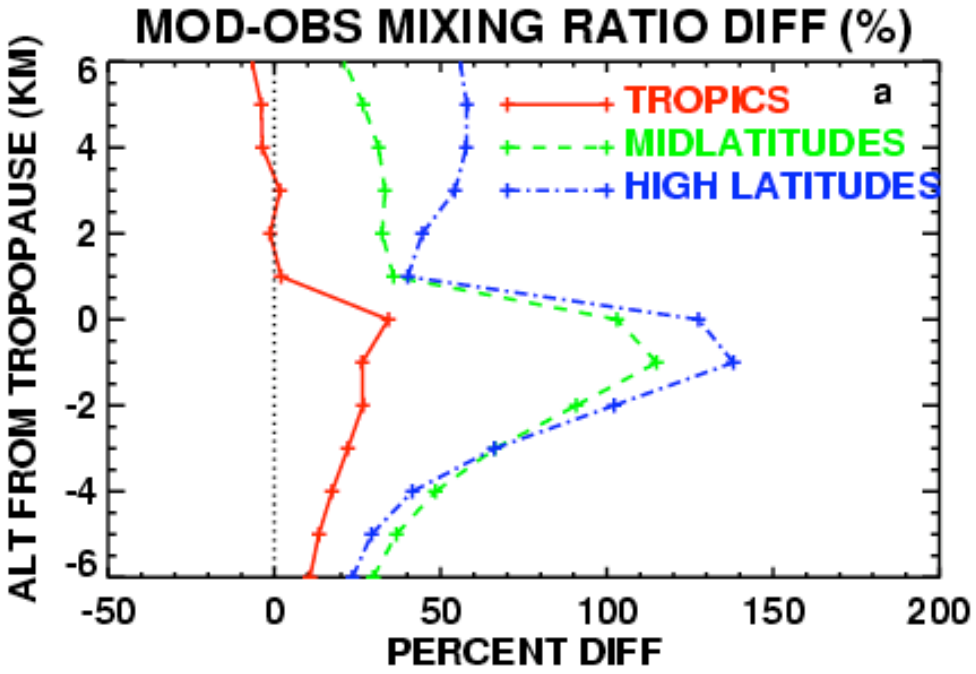
Boulder CO
November 18, 2004

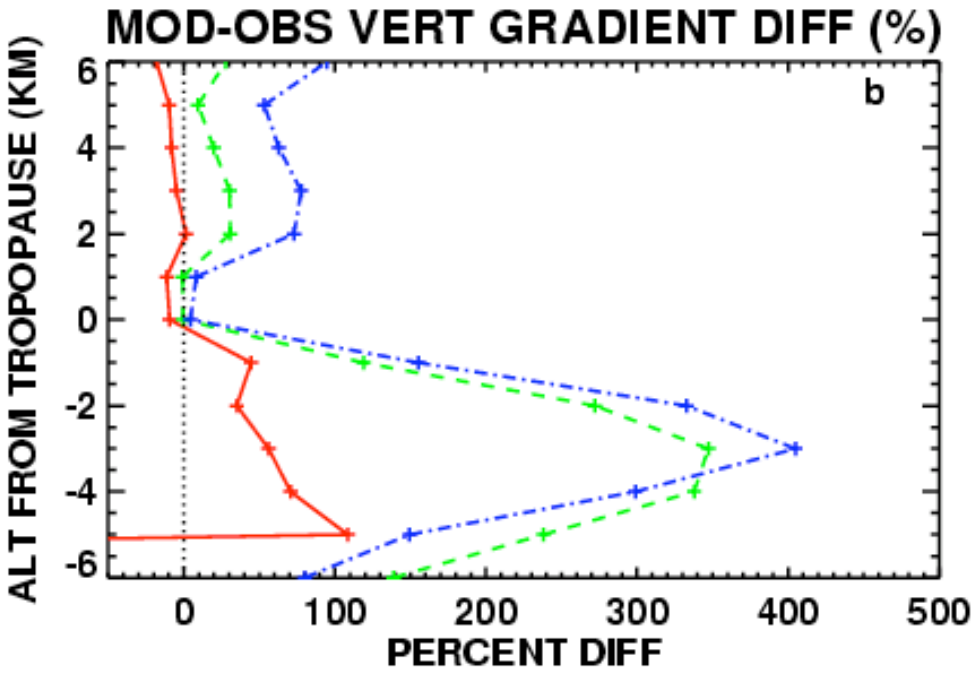
1. Combo model with Connell chemical mechanism is now running at GSFC.

- Took some time to resolve coding/implementation issues and reproduce Connell's original run.
- Modified code to fix problem with H2O diagnostics
- Stratospheric source gas BC's are now set
- 1 year run completed with lookup table photolysis coefficients and MACCM3 wind fields.
- Model run time at 4 x 5: ~ 60 cpu hrs/year, ~5 days wall clock time. (=> 480 cpu hrs/yr at 2 x 2.5 ???)
- Connell mechanism: 125 species, concatenation of LLNL strat mechanism & Harvard tropospheric mechanism, including inorganic chlorine & bromine, NMHCs, 322 thermal reactions, 82 photolytic decompositions, SMVGEAR II solver.

Comparison of GMI-combo O3 distribution with obs







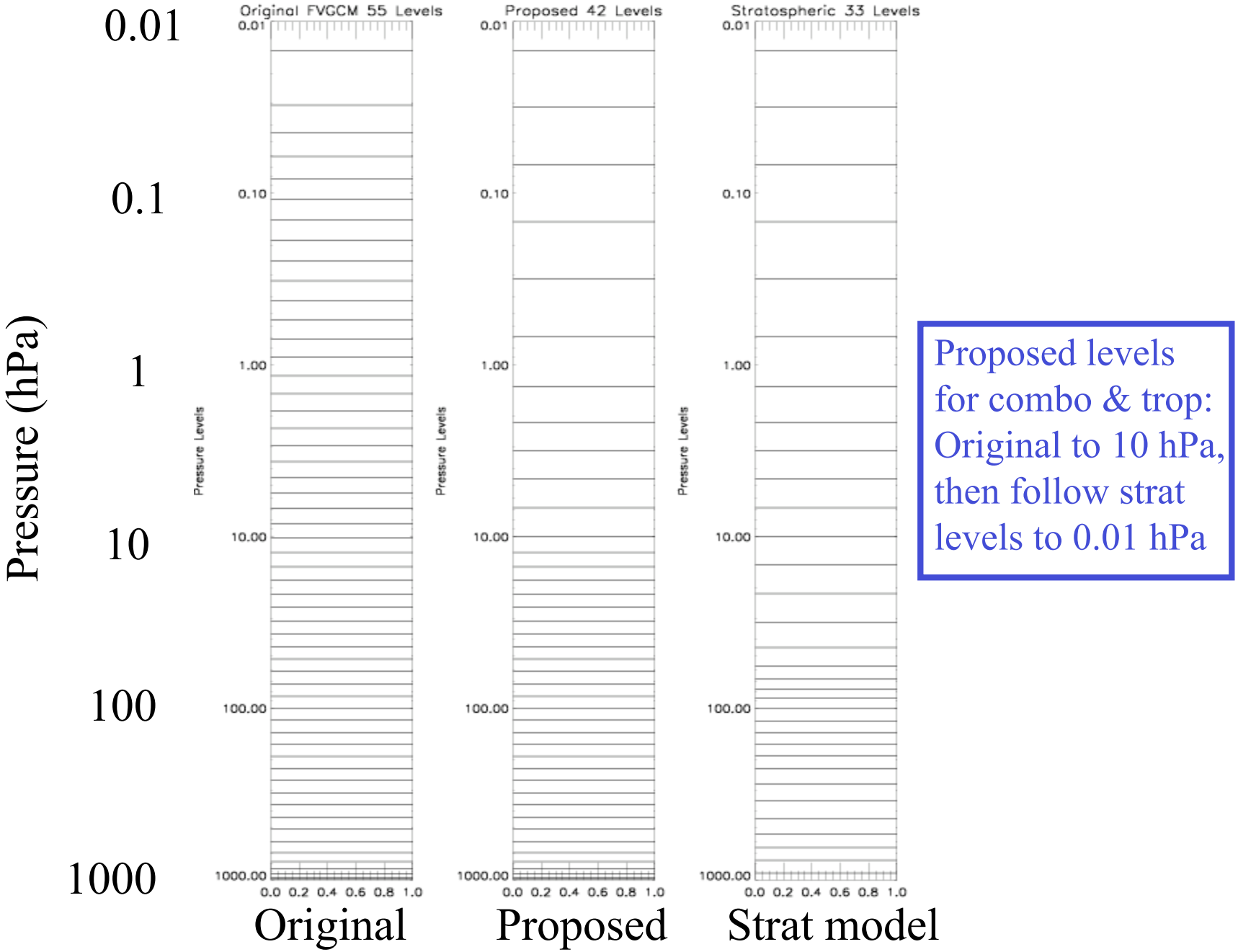
Combo model with MACCM3 wind fields exhibits elevated O3 mixing ratios and vertical gradients compared to Logan ozonesonde database

2. New Met Fields for Combo Model

- High priority combo model development issue.
- GSFC - continues to work on met field development from FVGCM, etc.
- Plans for 5-year dataset at 2 x 2.5 (July 1, 1993-Nov 30, 1998) Nov 30, 1998 is last day of 50-year FVGCM run which used observed SSTs. Goal: 12/04.
- Problem: Current combo model at 2 x 2.5 expected to take ~480 cpu-hours/year (~7-8 weeks wall clock).

➡ Interannual variability study not feasible with current compute resources; 1 year is trouble.

➡ Should we develop 4x5 FVGCM data set too?



Proposed levels for combo & trop: Original to 10 hPa, then follow strat levels to 0.01 hPa

3. LaRC Solver Implementation Progress

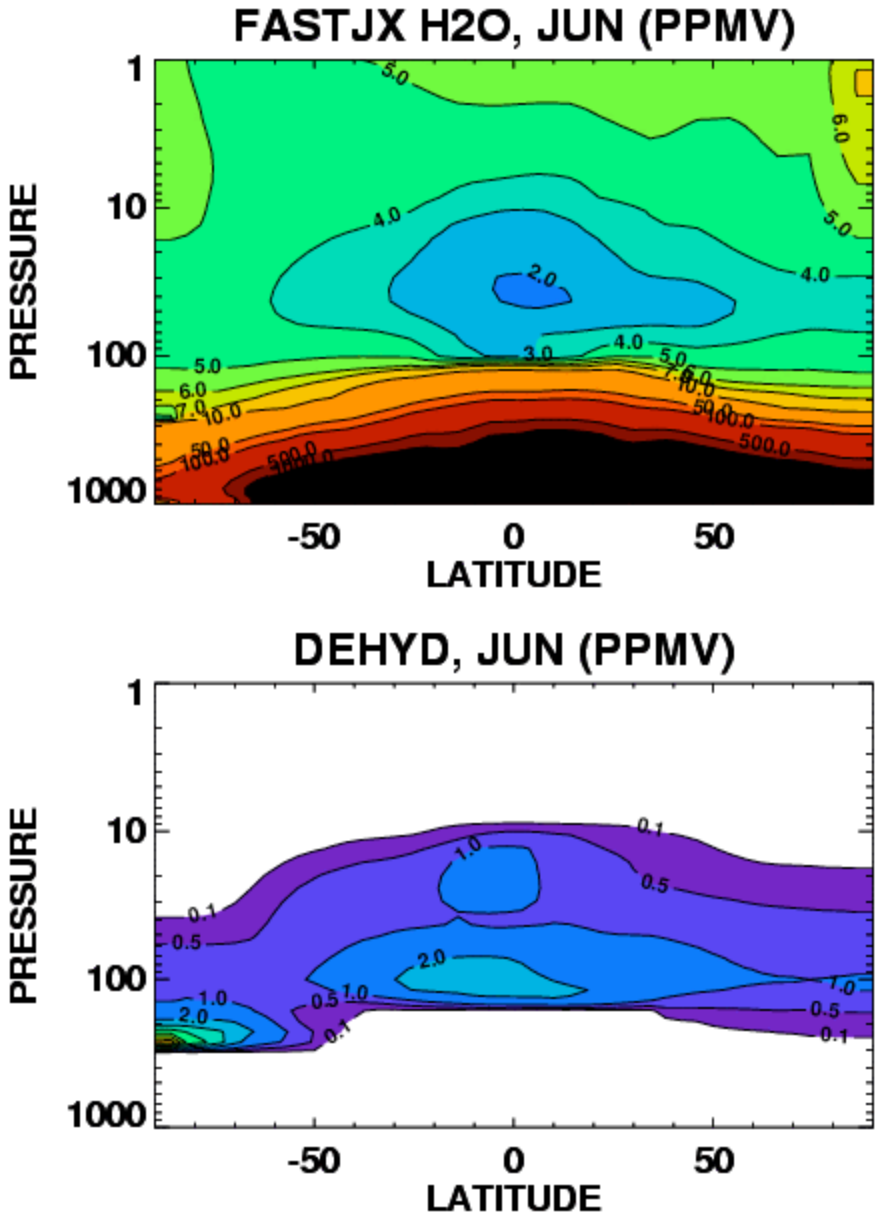
- Connell "KMG" software being run at GSFC

  Need to use software to generate setkin and other files needed to run GMI code.

- KMG database files describing LaRC mechanism under development at LaRC.
- Shell code to interface LaRC solver with GMI under development at LaRC.
- Emissions treatment an issue - emissions do not map one-to-one with LaRC species.
- Six month implementation timeline appears doable.

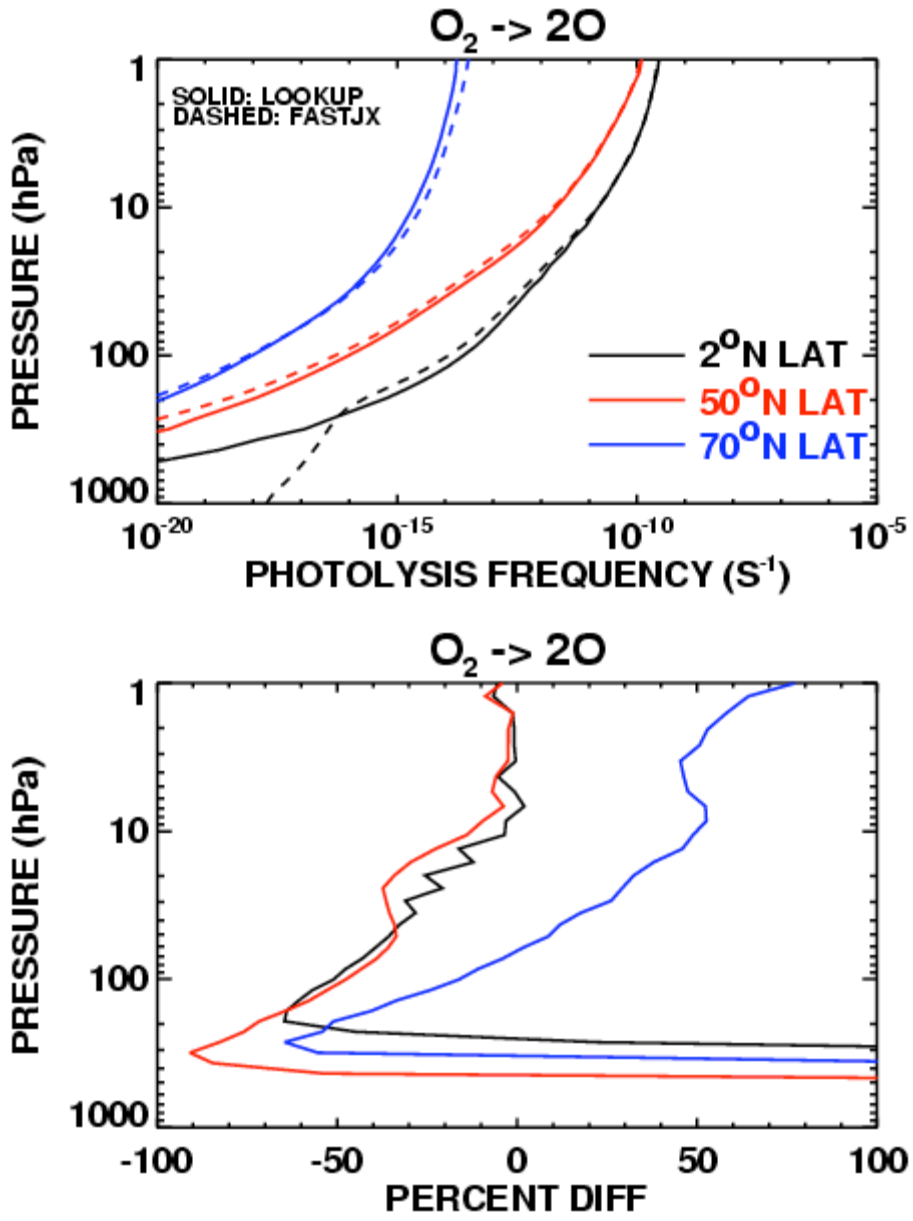
4. H2O treatment:

- Diagnostic problem resolved (3 ppm everywhere output fixed)
- Current treatment: met water vapor in troposphere, clim + dehyd + contributions from CH4 and aircraft H2O in strat
- Is dehyd a problem? Dehyd appears to be building up in tropical lower strat - need to look into it. (Also an issue for strat model).

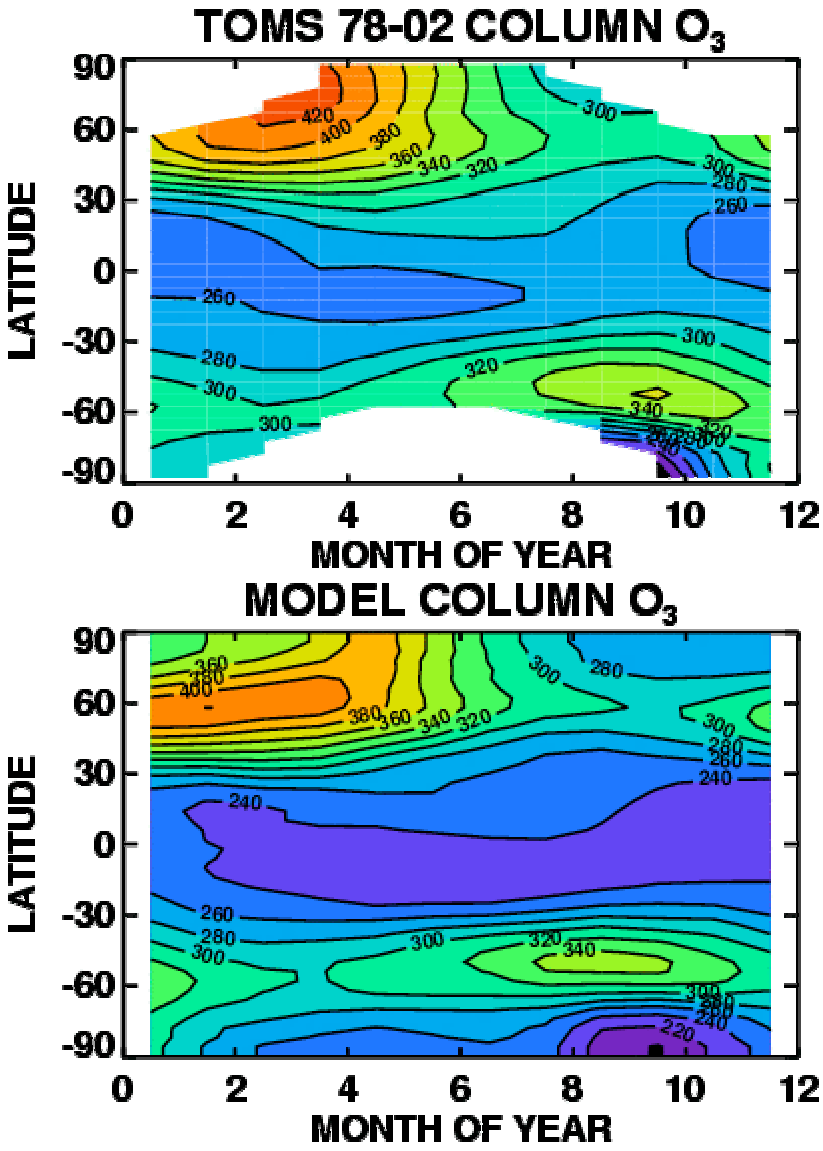


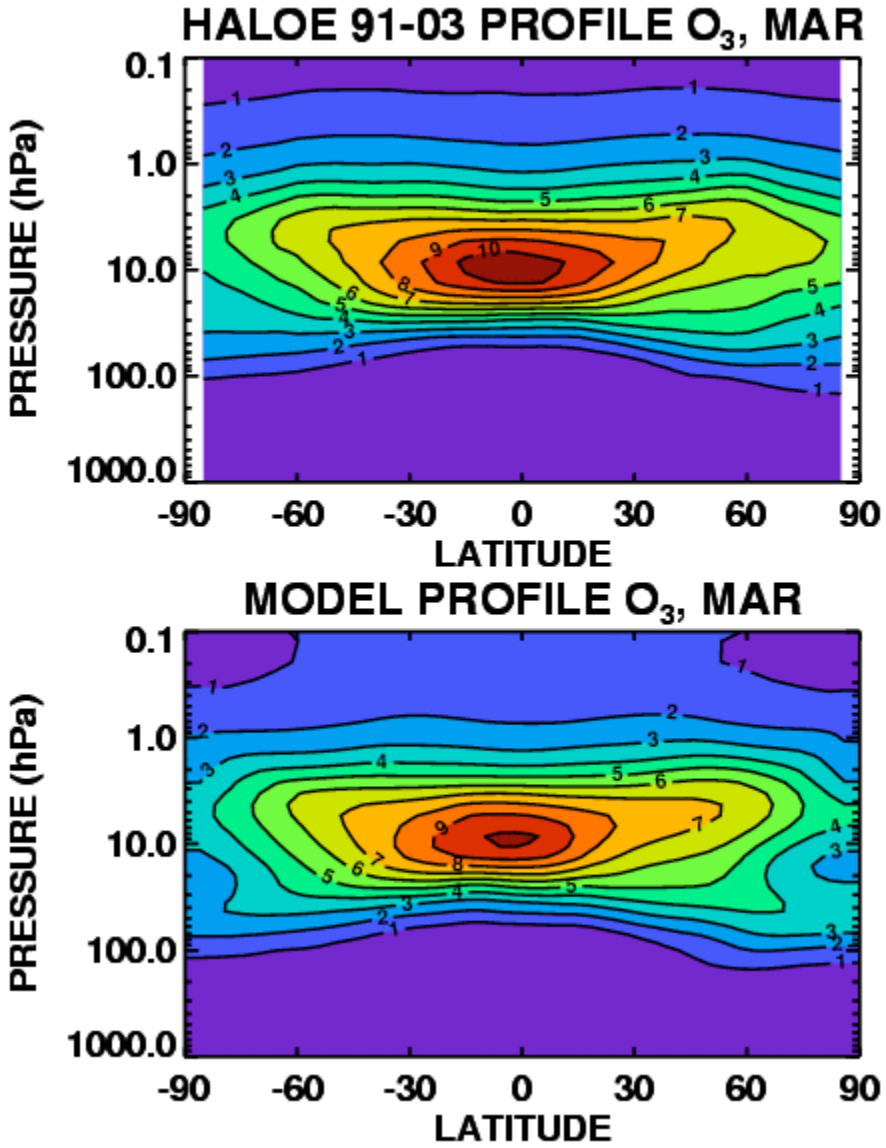
3. FAST-JX implementation

- Fast-jx code delivered to GSFC 7/27/04.
- Aug/Sept: implementation in GMI/strat.
- 1 year run of combo model with fastjx using model T&O3 fields completed 11/1/04.
- Currently looking at diffs between lookup table and fastjx runs.
- Unresolved implementation issues - spikey O(1D)
- Somewhat smaller than lookup table stratospheric O3, higher tropical UT OH.

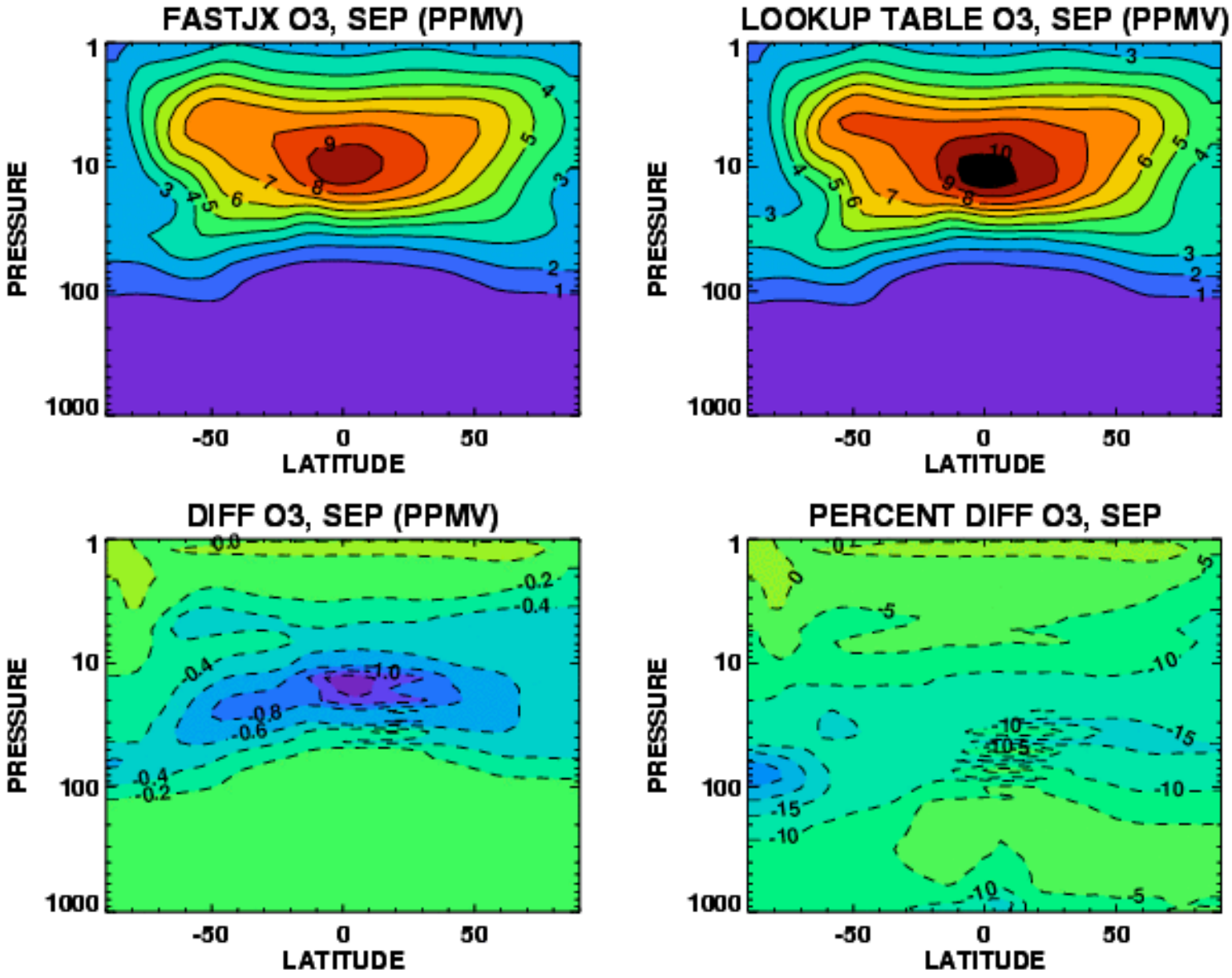

O2 -> 2O
SOLID: LOOKUP
DASHED: FASTJX
PRESSURE (hPa)
1
10
100
1000
10^-20
10^-15
10^-10
10^-5
PHOTOLYSIS FREQUENCY (S^-1)
2°N LAT
50°N LAT
70°N LAT
O2 -> 2O
PRESSURE (hPa)
1
10
100
1000
-100
-50
0
50
100
PERCENT DIFF

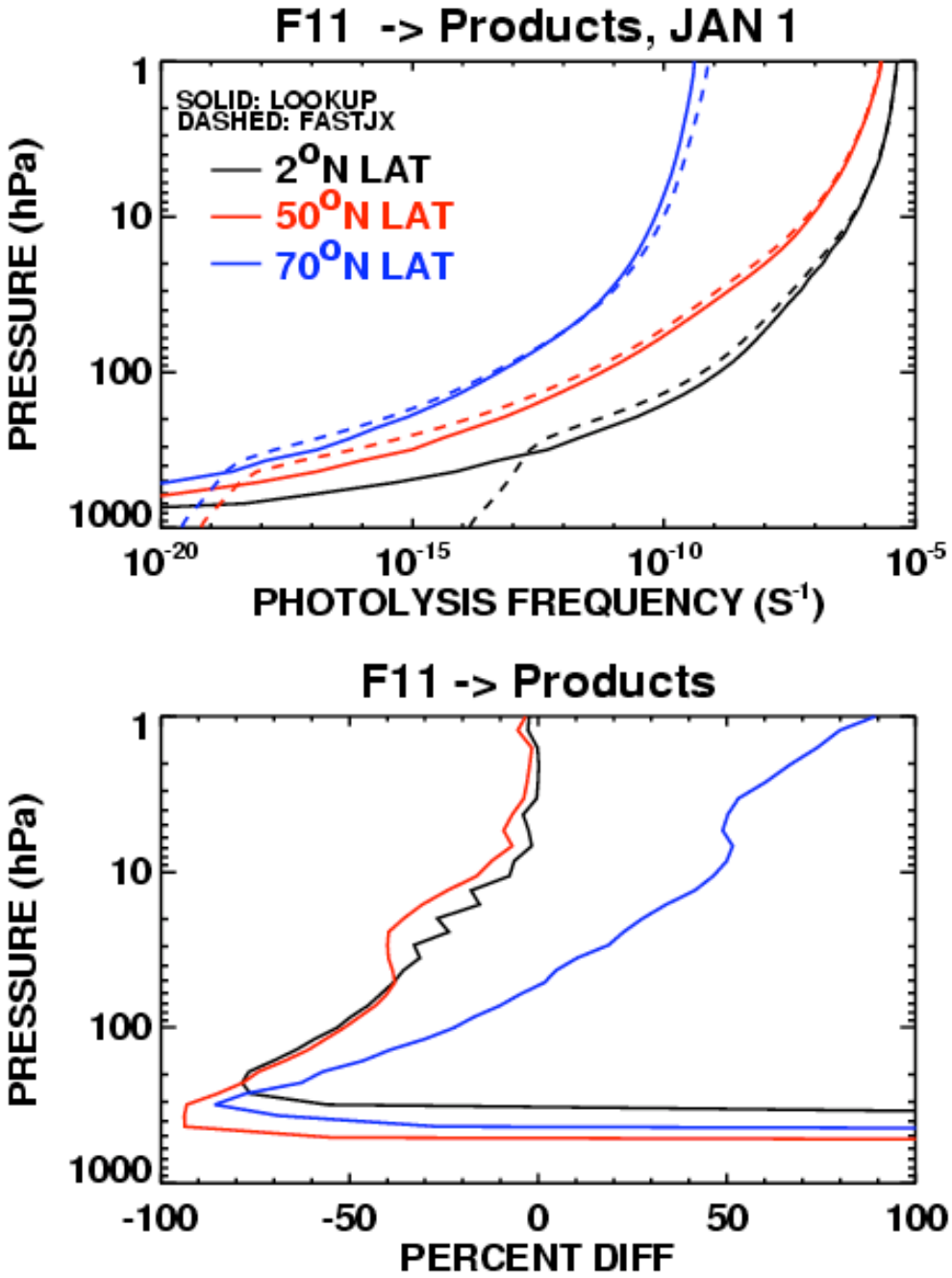
Combo model with FAST-JX photolysis

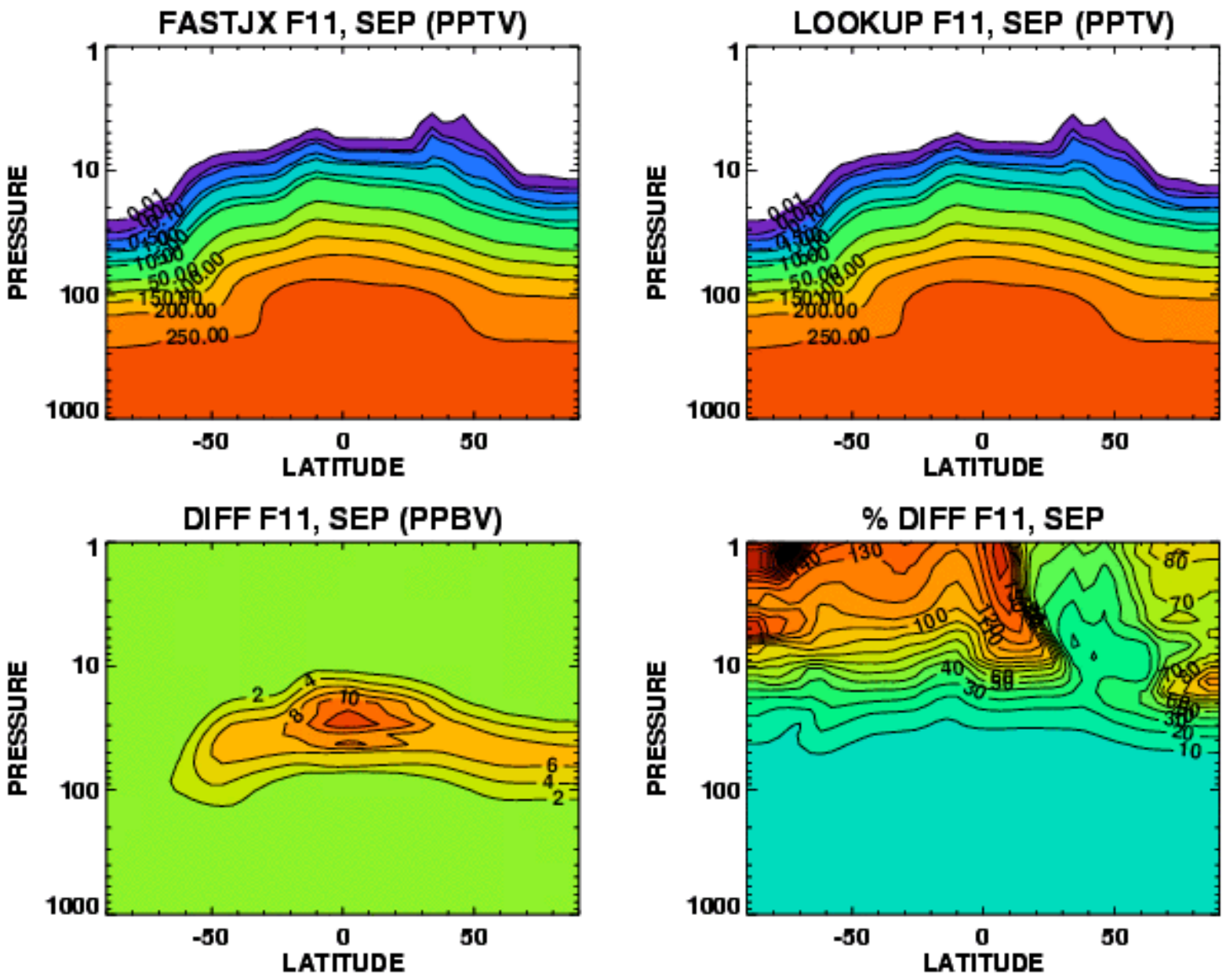


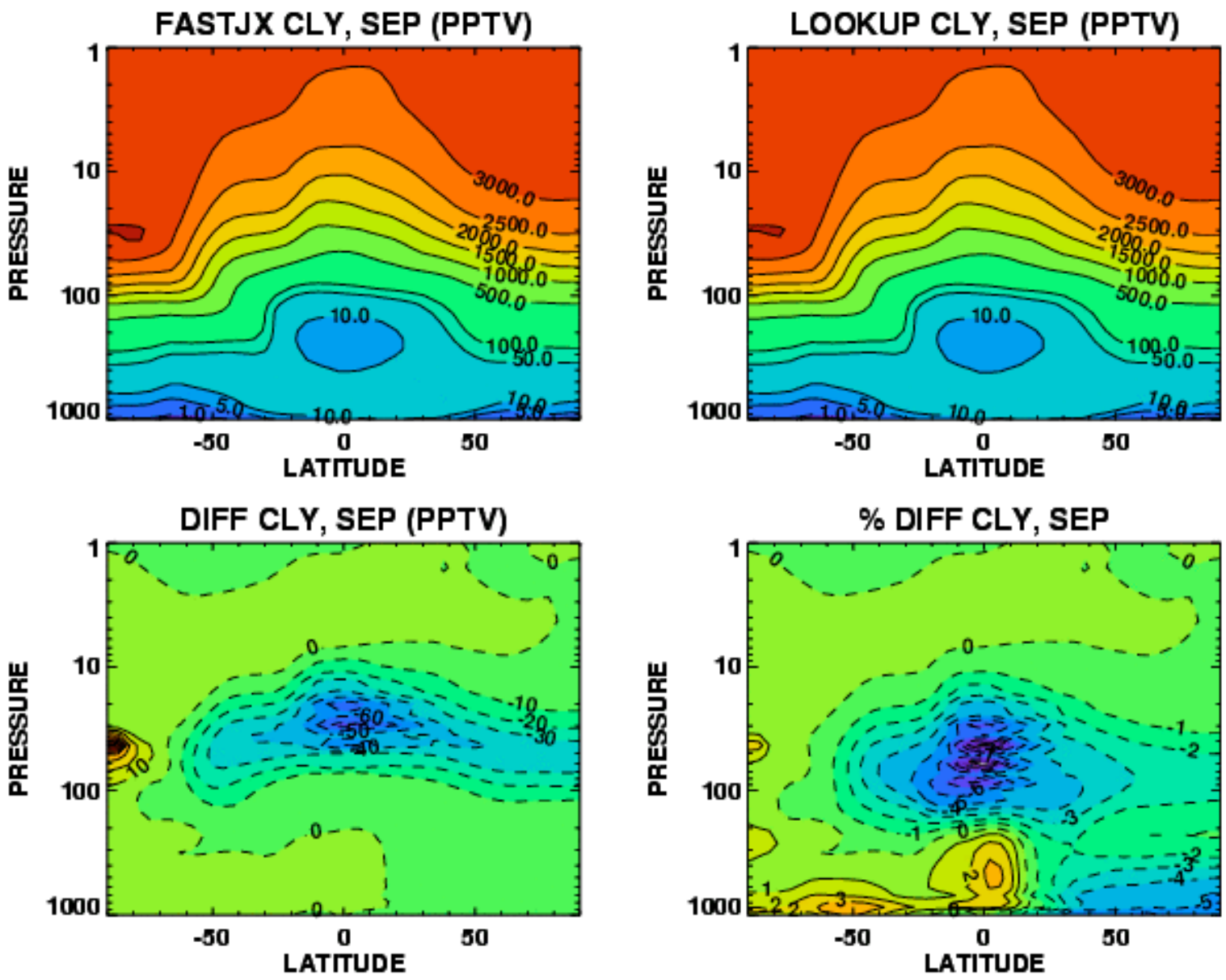


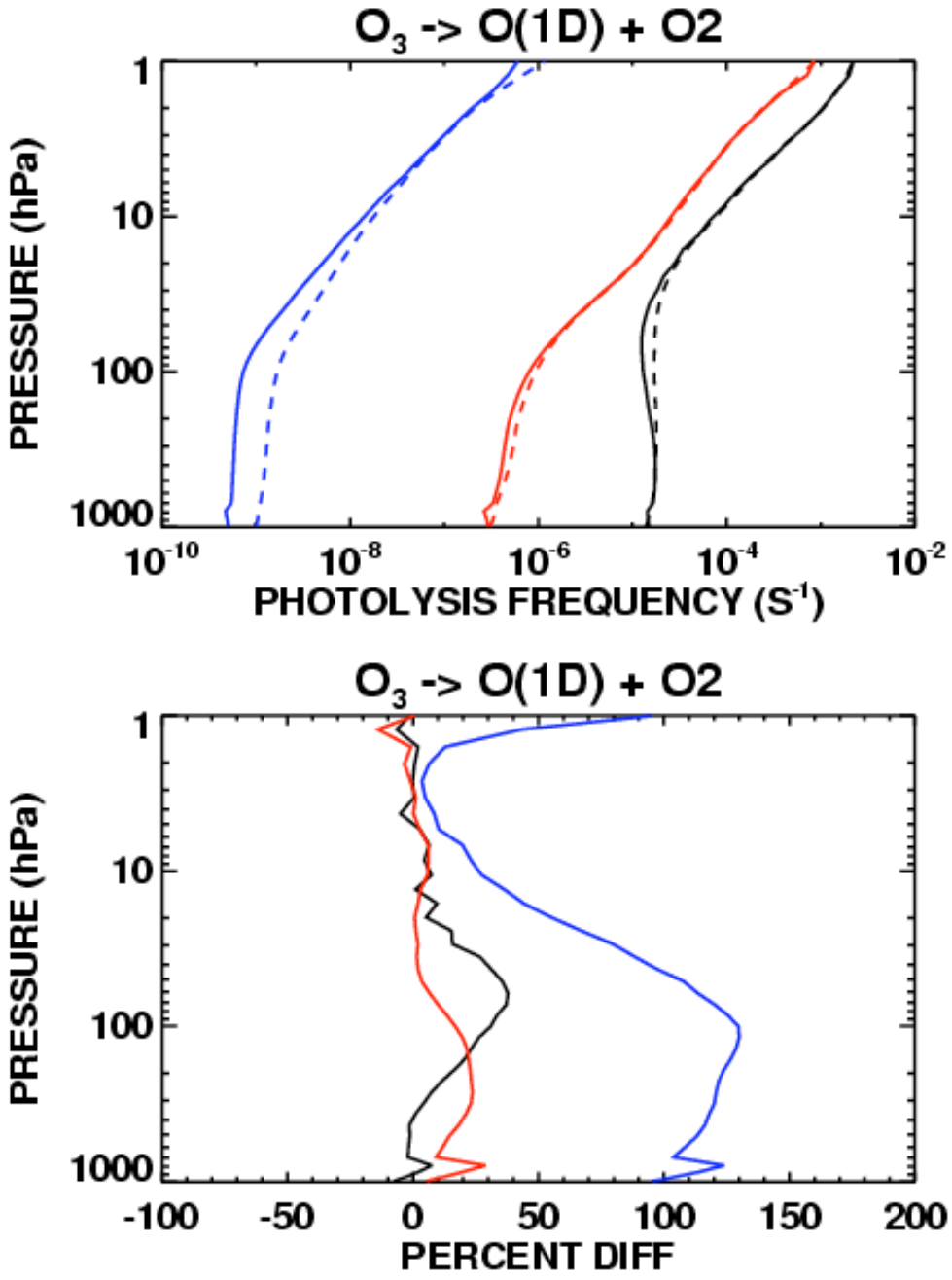
Fastjx O3 vs Lookup table O3, September

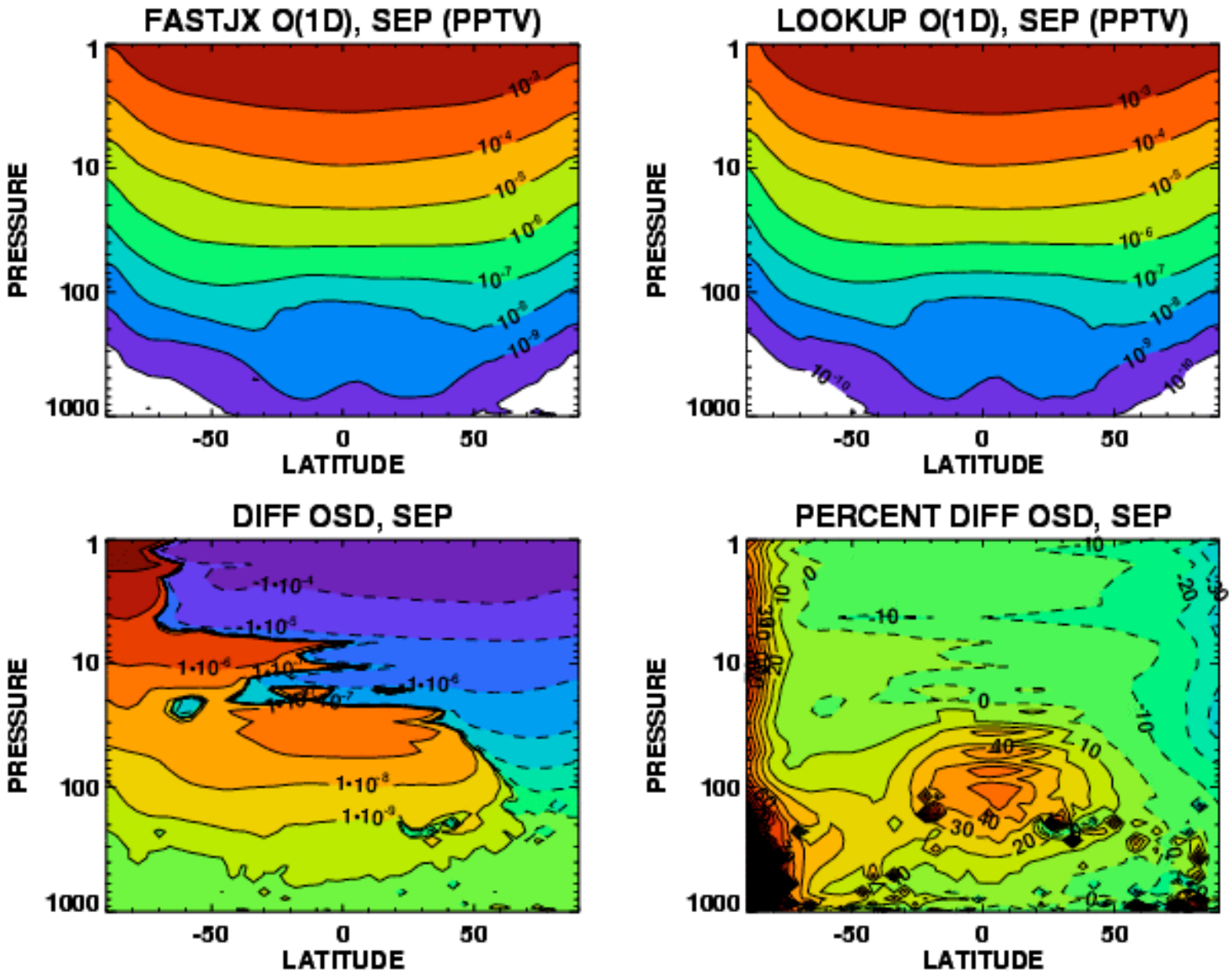


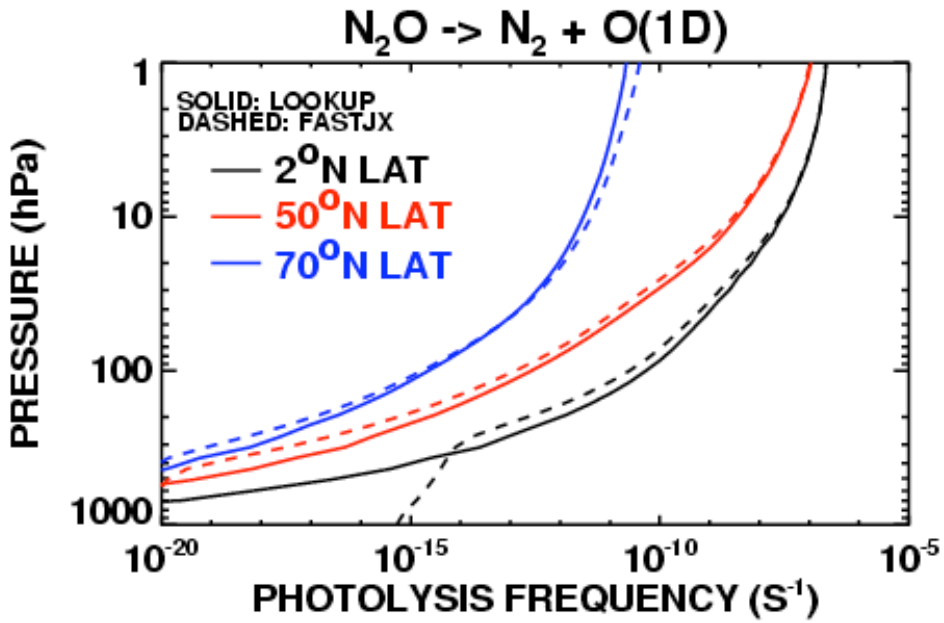

F11 -> Products, JAN 1
SOLID: LOOKUP
DASHED: FASTJX
2°N LAT
50°N LAT
70°N LAT
PRESSURE (hPa)
1
10
100
1000
10^-20
10^-15
10^-10
10^-5
PHOTOLYSIS FREQUENCY (S^-1)
F11 -> Products
PRESSURE (hPa)
1
10
100
1000
-100
-50
0
50
100
PERCENT DIFF

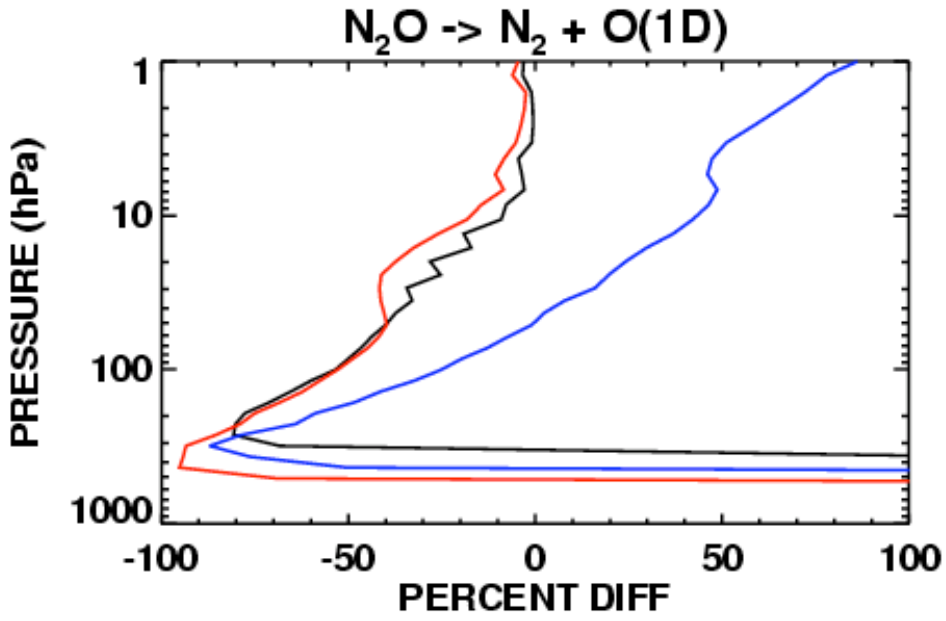

FASTJX F11, SEP (PPTV)
LOOKUP F11, SEP (PPTV)
DIFF F11, SEP (PPBV)
% DIFF F11, SEP
PRESSURE
LATITUDE
1
10
100
1000
-50
0
50
0.01
0.05
0.10
0.50
1.00
5.00
10.00
50.00
100.00
150.00
200.00
250.00
2
4
6
8
10
20
30
40
50
60
70
80
90
100
110
120
130

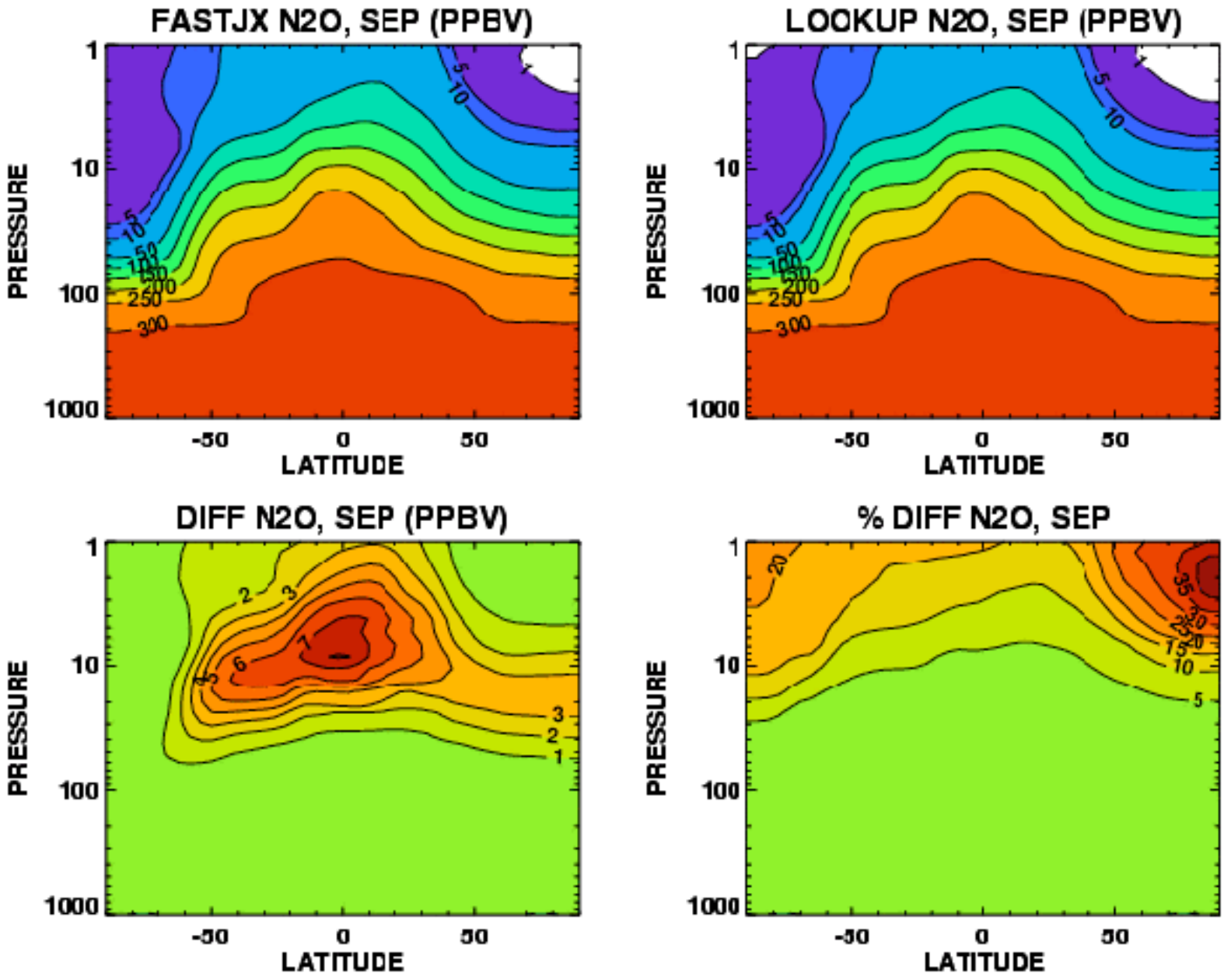

FASTJX CLY, SEP (PPTV)
LOOKUP CLY, SEP (PPTV)
DIFF CLY, SEP (PPTV)
% DIFF CLY, SEP
PRESSURE
LATITUDE
1
10
100
1000
-50
0
50
3000.0
2500.0
2000.0
1500.0
1000.0
500.0
100.0
50.0
10.0
5.0
1.0

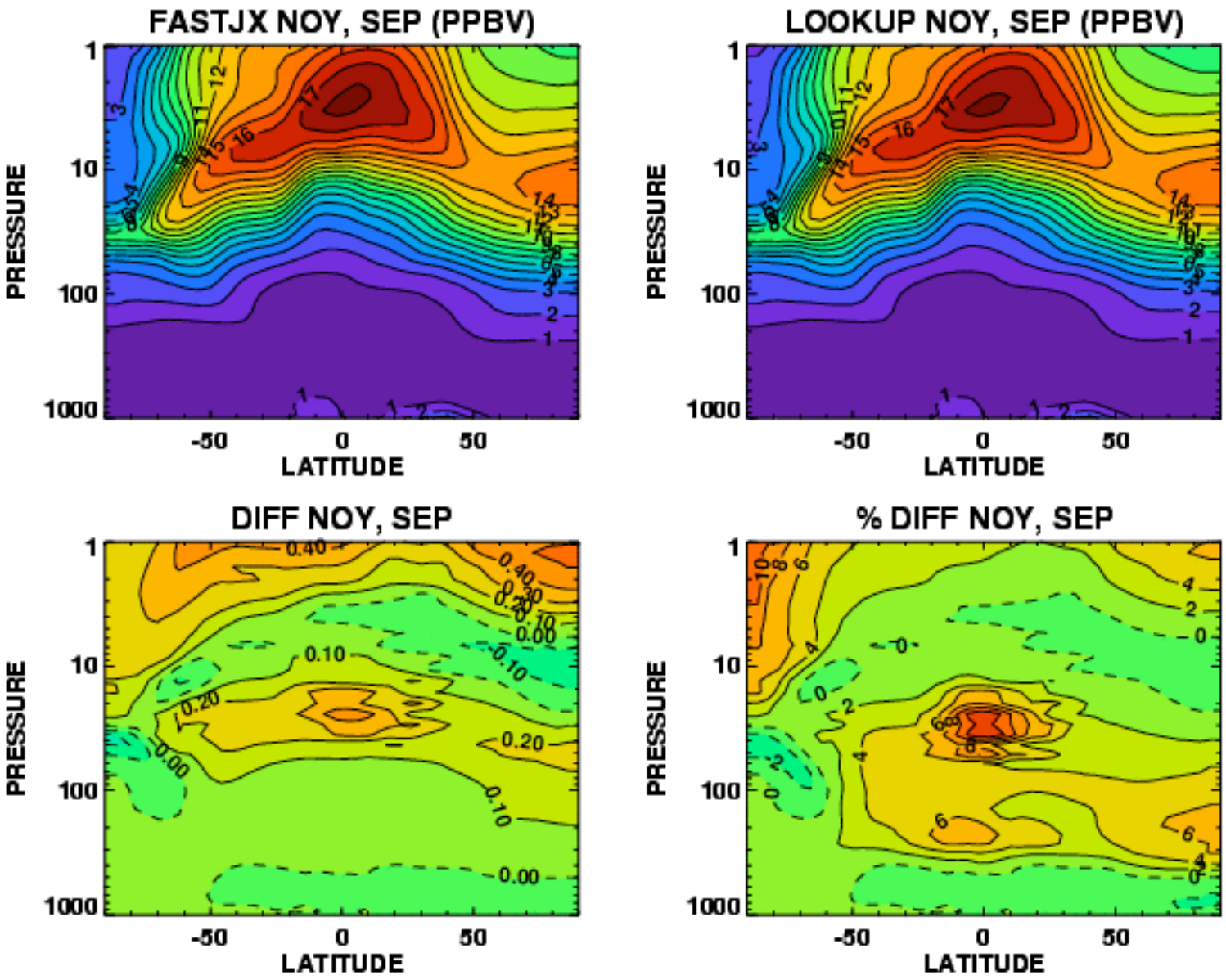

O_3 -> O(1D) + O2
PRESSURE (hPa)
1
10
100
1000
10^{-10}
10^{-8}
10^{-6}
10^{-4}
10^{-2}
PHOTOLYSIS FREQUENCY (S^{-1})
O_3 -> O(1D) + O2
PRESSURE (hPa)
1
10
100
1000
-100
-50
0
50
100
150
200
PERCENT DIFF

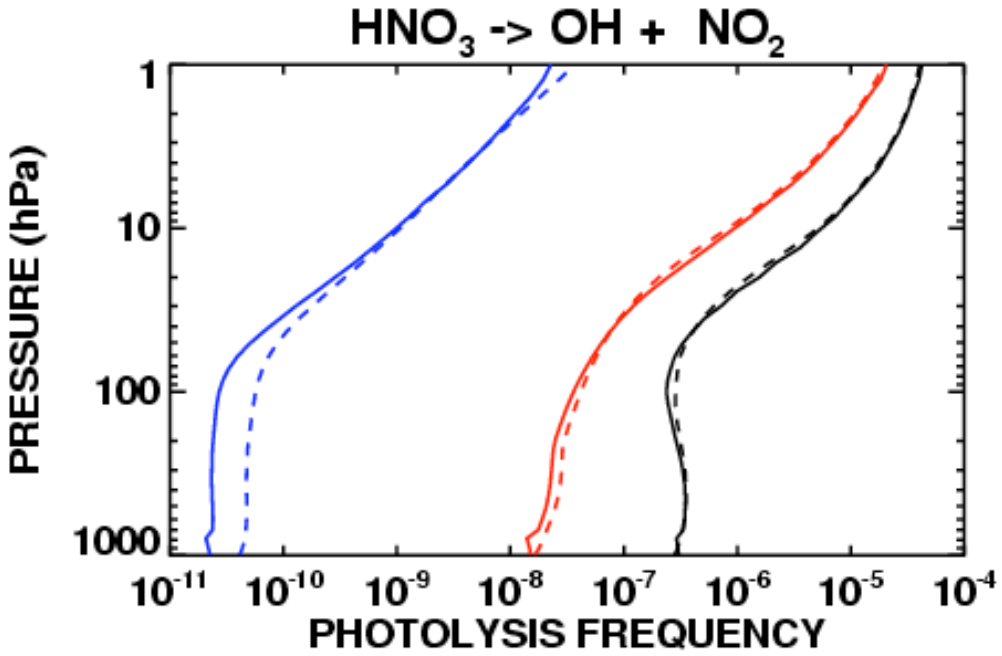

FASTJX O(1D), SEP (PPTV)
LOOKUP O(1D), SEP (PPTV)
DIFF OSD, SEP
PERCENT DIFF OSD, SEP
PRESSURE
LATITUDE
1
10
100
1000
-50
0
50

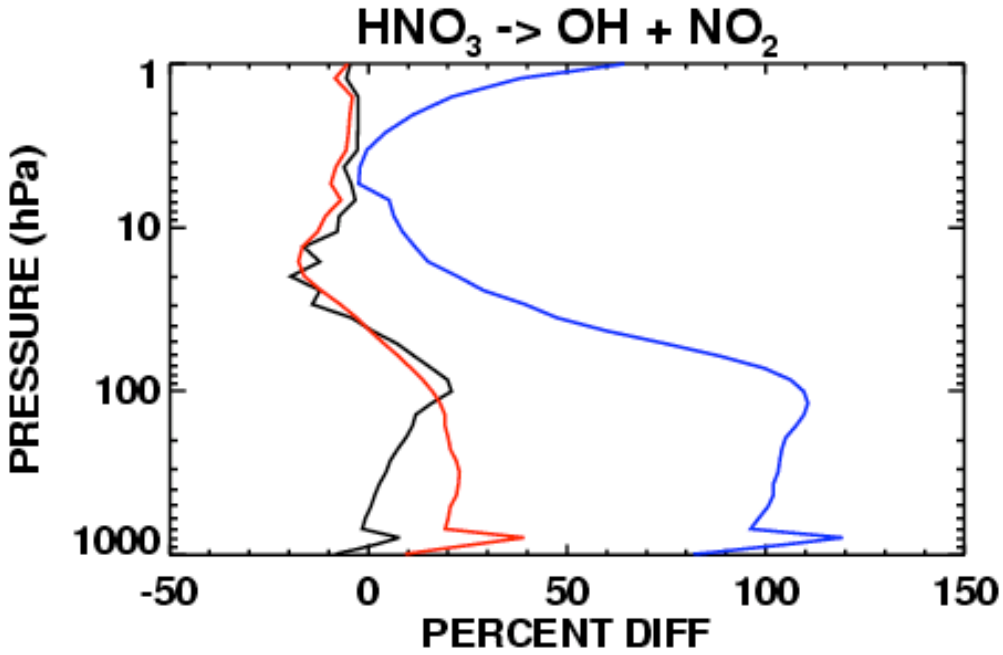

N2O -> N2 + O(1D)
SOLID: LOOKUP
DASHED: FASTJX
2°N LAT
50°N LAT
70°N LAT
PRESSURE (hPa)
1
10
100
1000
10-20
10-15
10-10
10-5
PHOTOLYSIS FREQUENCY (S-1)

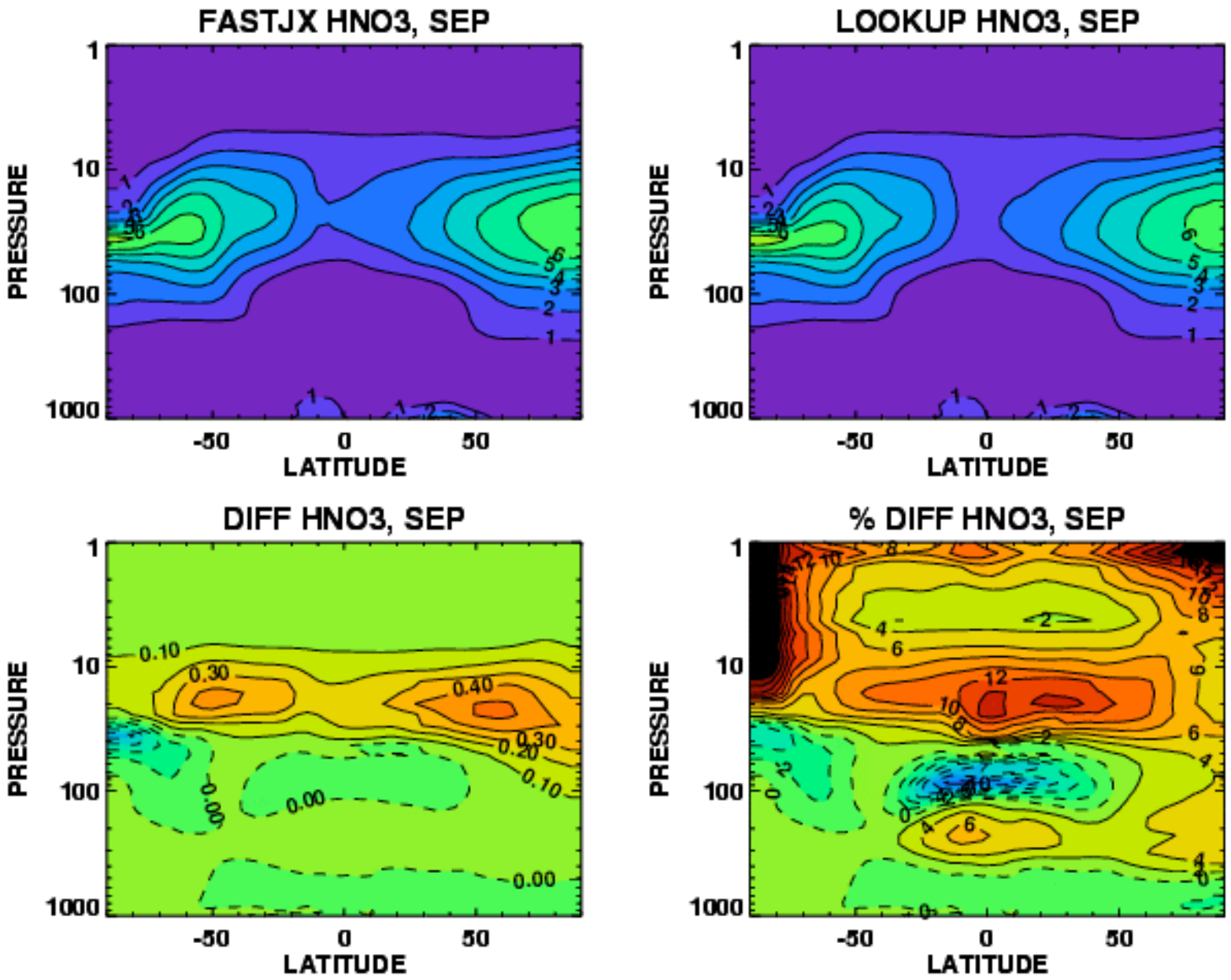

N2O -> N2 + O(1D)
PRESSURE (hPa)
1
10
100
1000
-100
-50
0
50
100
PERCENT DIFF

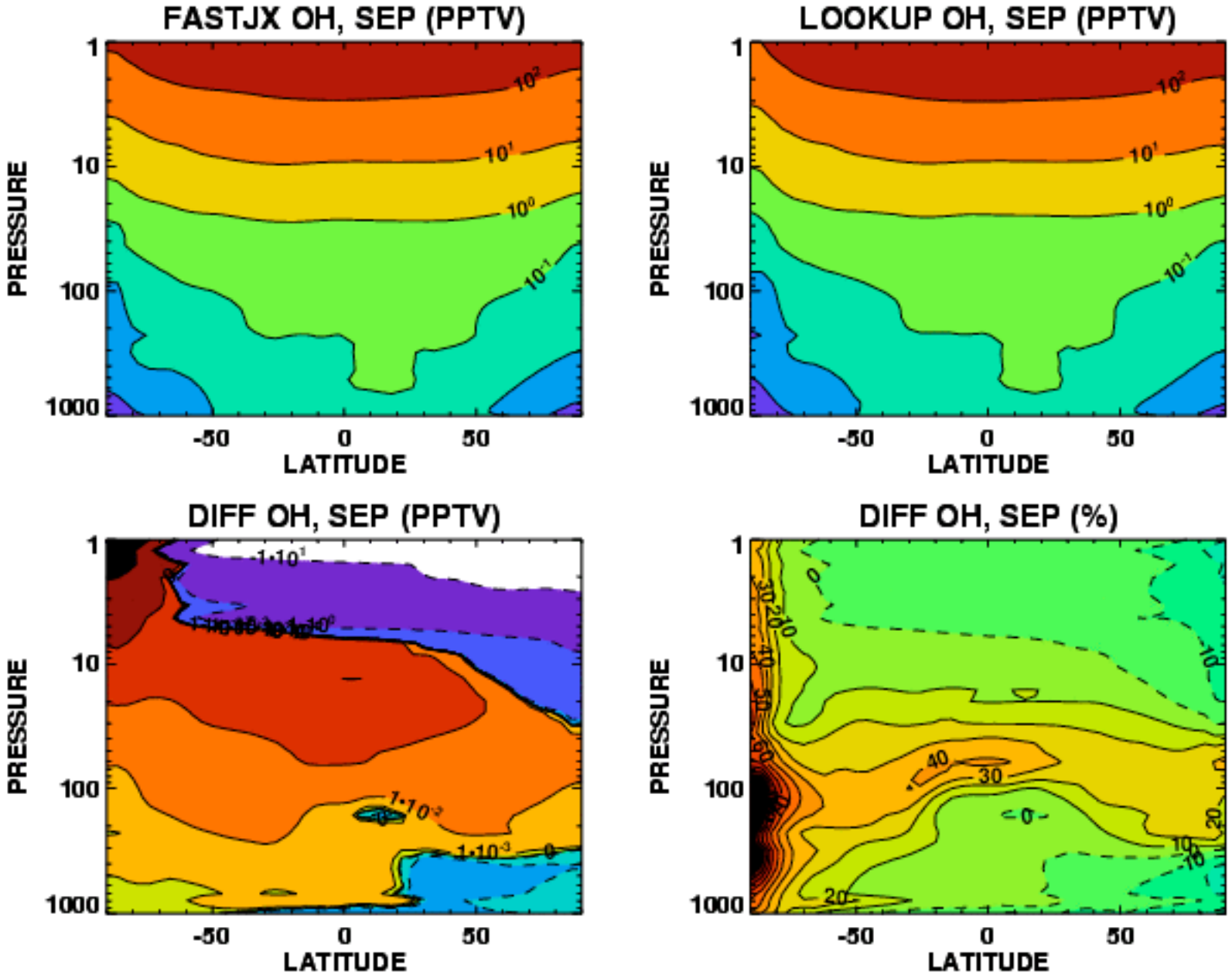

FASTJX N2O, SEP (PPBV)
LOOKUP N2O, SEP (PPBV)
DIFF N2O, SEP (PPBV)
% DIFF N2O, SEP
PRESSURE
LATITUDE
1
10
100
1000
-50
0
50

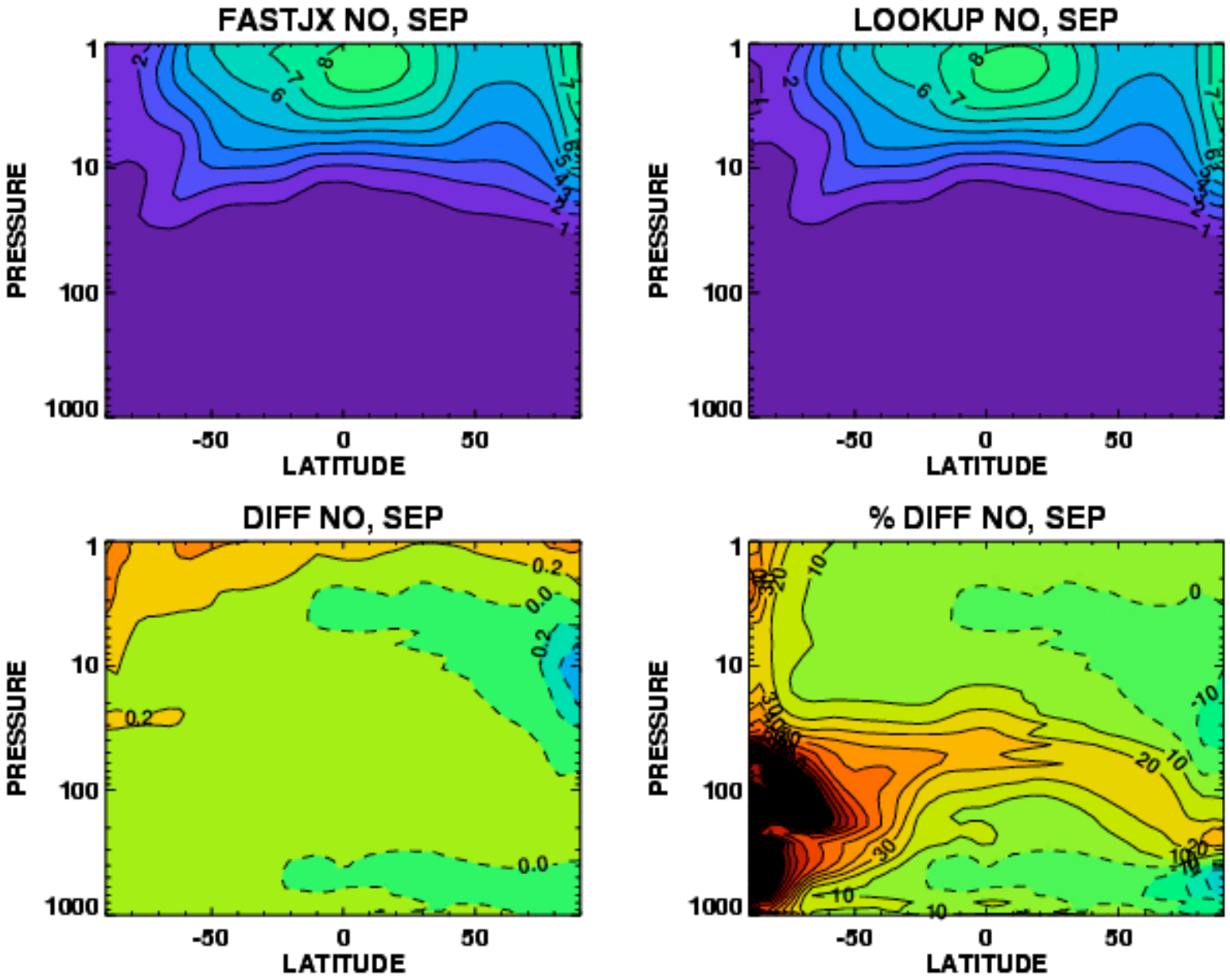

FASTJX NOY, SEP (PPBV)
LOOKUP NOY, SEP (PPBV)
DIFF NOY, SEP
% DIFF NOY, SEP
PRESSURE
LATITUDE
1
10
100
1000
-50
0
50


HNO3 -> OH + NO2
PRESSURE (hPa)
1
10
100
1000
10-11
10-10
10-9
10-8
10-7
10-6
10-5
10-4
PHOTOLYSIS FREQUENCY


HNO3 -> OH + NO2
PRESSURE (hPa)
1
10
100
1000
-50
0
50
100
150
PERCENT DIFF


FASTJX HNO3, SEP
LOOKUP HNO3, SEP
DIFF HNO3, SEP
% DIFF HNO3, SEP
PRESSURE
LATITUDE
1
10
100
1000
-50
0
50
0.10
0.30
0.40
0.20
0.00


FASTJX OH, SEP (PPTV)
LOOKUP OH, SEP (PPTV)
DIFF OH, SEP (PPTV)
DIFF OH, SEP (%)
PRESSURE
LATITUDE
1
10
100
1000
-50
0
50


FASTJX NO, SEP
LOOKUP NO, SEP
DIFF NO, SEP
% DIFF NO, SEP
PRESSURE
LATITUDE
1
10
100
1000
-50
0
50